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22 GHz VLBI Survey: Status Report and Preliminary Results

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Abstract: A ground-based VLBI survey to measure the visibilities and correlated flux densities in continuum at 22 GHz of more than 140 extragalactic radio sources has been conducted with baselines up to $\approx$ 11000 km. The project has been designed to help in preparation of target lists for VSOP and RadioAstron Space VLBI missions as well as providing observational data for statistical study of structural properties at 22 GHz on sub-milliarcsecond scales for this large sample of extra galactic sources.

1. INTRODUCTION

Space VLBI missions will provide baseline lengths up to 30000 km (VSOP) and 85000 km (RadioAstron). In order to make efficient use of observing time with two orbiting antennas, multifrequency estimates of correlated flux densities on these baselines are needed. To some extent, these estimates can be based on parameters which can be determined with single dish observations: total flux density, spectral and variability indices. However, two much more representative parameters are the correlated flux density and source visibility on long ground baselines (8000 - 10000 km). Sources with large correlated flux densities and/or high visibilities are almost certain to be visible over at least some of the range of VSOP baselines, and are the best candidates for observations with RadioAstron.

Extensive ground-based VLBI surveys of more than 900 extragalactic radio sources with intercontinental baselines have been performed at 2.3 and 8.4 GHz (Preston *et al.* 1985, Morabito *et al.* 1986). More than 200 extragalactic radio sources have been imaged with VLBI at 5 GHz in recent years (e.g. Eckart *et* al. 1987, Pearson and Readhead 1988, Taylor *et al.*, Thakkar *et al.* 1994). Successful detections on baselines of 1 - 2.4 Earth diameters were made on 23 of 24 sources in the first Space-Ground VLBI experiment using an antenna on a TDRSS satellite at 2.3 GHz (Linfield *et al.* 1989), At 15 GHz, the detection rate in TDRSS Space Ground demonstration VLBI experiment was lower, but so was the sensitivity of a small (5 m diameter) antenna. This indicates that sources can be detected on baselines of at least 40000 km (Linfield *et al.* 1990).

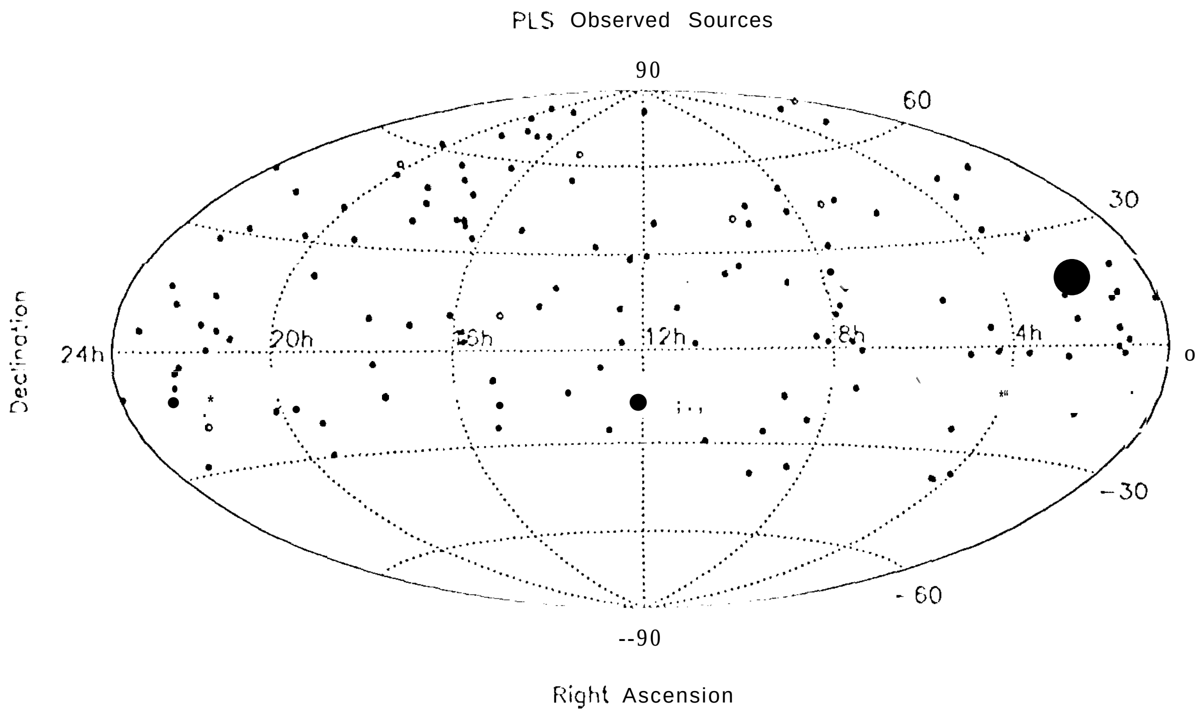

Figure 1: Sky distribution of sources observed in VLBI survey at 22 GHz. Filled circles show detected sources, open circles-]~on-detected.

Muc.bless extc)~siveglound-based VLBI observations have been performed at 22 GHz. Lawrence *et al.* (1985) have detected 25 of 26 sources observed with baselines up to $\approx 5X\,10^8\lambda$ ($\approx$ 7000 km). Only a. few strongest sources (e.g. 3C84, 3C273, 3C345) which were well studied at lower frequencies have also been extensively imaged with VLBI at 22 GHz. Recently a sample of 15 bright AGN has been observed at 22 GHz with a global V] ,BI network (Wiik and Valtaoja, this Symposium).

The discussed survey allows a substantial enlargement to the list of sources suitable for follow up VLBI observations at 22 GHz with ground and space ground VLBI.

It also has been shown that data from a non-imaging VLBI survey of a large enough sample of optically identified extragalactic sources can be used in order to conduct a cosmological study (Gurvits 1994).

2. SAMPLE SELECTION, OBSERVATIONS, AND DATA REDUCTION

The sample has been compiled using the following criteria: total flux density $S_{22} > 1$ Jy, spectral index around 22 GHz $\alpha >$ -0.5. A total of '211 sources have been found in literature that conform to the above criteria, including 150 with $\delta > 0$. In order to increase the number of southern sources we added to the sample 28 sources with $S_{15} > 1$ Jy and spectral index in GHz range $\alpha > -0.5$.

The sample contains all 26 sources from the previous 22 GHz VLBI survey (Lawrence *et al.* 1985) and all 4? suggested sources for mm and Space VLBI (Valtaoja *et al.* 1992).

The observations have been carried out in 8 sessions in 1593. The following antennas have been used (although not always all in each session): Goldstone (70 In), Tidbinbilla (70 m), Nobeyama

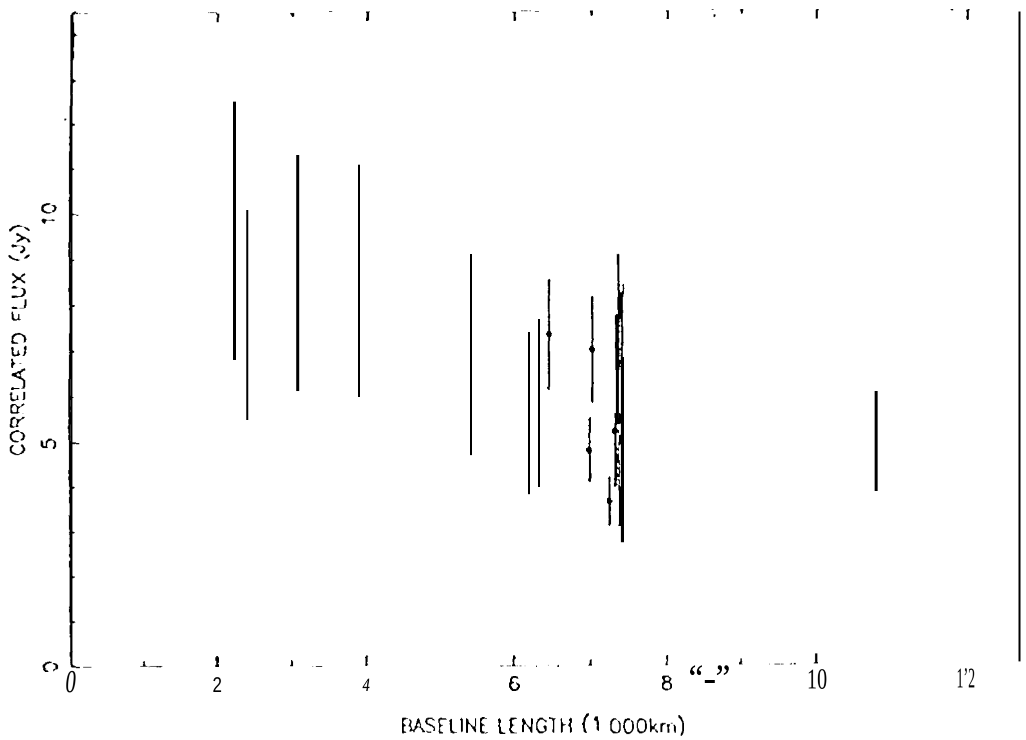

Figure 2: Correlated flux density versus projected baseline for the source 1253-055.

(45 m), Kashima (34 m), VLBA Brewster (25 m), VLBA Mauna Kea (25 m). Nobeyama radio telescope was also used for total flux density measurements of all observed sources. Data had been recorded in Mk3A mode B format (28 MHz bandwidth), using high-density (narrow-track) terminals, and correlated at the 4-station Caltech/JPL correlator in Pasadena.

3. PRELIMINARY RESULTS AND CONCLUSIONS

The allocated amount of time allowed observation of 142 sources, each source at at least 3 hour angles. A total of 135 sources has been detected ($SNR>7$ with an integration time of 4 minutes). Fig. 1 shows the distribution of the observed 142 sources over the sky.

Table 1 represents distribution of detected and non-detected sources over various types of optical counterpart objects according to classification of Véron-Cetty and Véron (1 993). Redshifts are known for 122 out of 135 detected sources,

Table 1. The distribution of observed 142 sources over optical counterpart types

	Quasars	BL Lacs	Other AGN	Empty fields
Detected	99	23	7	6
Non-detected	4	1	1	1
Total	103	24	8	7

Fig. 2 shows *a* typical example of the available data. As a general statement we note that almost all detected sources show decreases in correlated flux density with increasing projected baseline. However, at least 30% of the observed sample is composed of sources which have high enough correlated flux density to be primer candidates for observations with VSOP and Radio oAstron. Further analysis will allow better specification of these sources.

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